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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Centrifugal Cleaner.

We, THE BAUER BROS. CO., a Corporation organised under the laws of the State of Ohio, United States of America, of Sheridan and Burt Streets, Springfield, Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to centrifugal separators, and particularly to hydrocyclones for separating a liquid suspension of solids or slurry into accepted and rejected fractions. Although not so limited, the invention has particular reference to a conical separator, sometimes known as a cleaner, used in paper making processes to separate clean, usable fibrous material from a flowing slurry which, in addition to the usable material, contains unwanted dirt and coarse particles.

In a conventional embodiment thereof a hydrocyclone as described comprises a short cylindrical section connected to a circular conical section truncated near the apex. An inlet at the base or cylindrical end discharges the slurry tangentially into the hollow body of the separator in a manner to cause the slurry to progress from one end to the other of the separator in a swirling motion. The apex end of the separator is open, as is the base end wherein a nozzle or finder is located to receive and guide an inner vortex in which is comprised the accepted fraction of solids, the rejected fraction discharging through the apex end of the separator. The nozzle arrangement at the base end is considered as providing for "overflow", with "underflow" taking place at the apex end. These terms do not denote attitude limitations since the separator can be mounted in any position convenient from an installation standpoint, the speed of movement of the slurry through the separator making the device operationally independent of gravity.

The object of the invention is to simplify the construction as well as the means and mode of operation of centrifugal cleaners, whereby such cleaners may not only be economically manufactured, but will be more efficient and satisfactory in use, adaptable to a wide variety of applications, and be unlikely to get out of order.

A further object of this invention is to bring about improvement in the inlet or overflow region of the separator to the end that operation will at the same time be made more effective and more efficient.

Another object of the invention is to exert increased control over the admission of the fluid slurry to the separator and over flow circulation in regions of low radial velocity in a manner to minimize turbulence effects with consequent improvement in the ratio of flowthrough rate to pressure drop.

A further and related object is to achieve given flow rates through the separator under conditions of reduced pressure drop whereby to make possible corresponding reductions in pump operating power requirements.

Still another object of the invention is to present a generally new nozzle assembly constructed to achieve flow effects as above described and adapted in addition to limit short circuiting movements of the liquid slurry into the overflow nozzle by forcing eddy currents away from the entrance end of the nozzle to reduce by-passing flow thereto of dirt-rich fractions.

A still further object of the invention is to provide a nozzle assembly as described which may be substituted as a unit in existing separator devices.

A further object of the invention is to pro-

vide a centrifugal cleaner possessing the advantageous structural features, the inherent meritorious characteristics and the mode of operation herein mentioned.

With the above and other incidental objects in view as will more fully appear in the Specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

Referring to the accompanying drawing wherein is shown one but obviously not necessarily the only form of embodiment of the invention.

Fig. 1 is a view in perspective of an overflow nozzle assembly in accordance with the illustrated embodiment of the invention;

Fig. 2 is a view, partly diagrammatic, of a conical hydrocyclonic separator having the overflow nozzle of Fig. 1 installed therein; and

Fig. 3 is a view in longitudinal section of the nozzle assembly of Fig. 1.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to Fig. 2, a hydrocyclonic separator of the kind to which this invention has special reference comprises a shell 10 suitably formed in one piece or fabricated into a unitary structure, as by being made of a plurality of sections bolted or otherwise secured together. Included in the shell 10 is a portion 11 having the shape of a truncated cone, the interior of portion 11 being hollow to define a separating chamber 12. The opposite ends of a chamber 12 open through the opposing or base and apex ends of the cone. Further comprised in the shell 10 is a cylindrical portion 13 on the base end of conical portion 11 and in superposed aligned relation thereto. The outer end of cylindrical portion 13 is closed, by means hereinafter more particularly to be described, while adjacent to such outer end is an opening 14 forming a part of a laterally disposed inlet 15 offset to lie in a line tangential to a circle concentric with the longitudinal axis of the shell. The inlet 15 is adapted to be connected in a system supplying a liquid suspension or slurry under pressure. The arrangement is one to introduce such slurry into the cylindrical portion 13 of shell 10 tangentially, the continued application of pressure of the inlet causing the liquid suspension to progress from the base end of the separator device to the apex end in a swirling motion inducing centrifugal forces. As a result of these forces there is left in the axis of the device a liquid-free core area of low pressure and an inner vortex of fluid moving contra to the outer vortex, that is in a direction from the apex end to the base end. Finder or nozzle means located in the overflow end of the device has an inner end extending inwardly of the shell to receive the inner vortex and to conduct it out of the shell. The outer end of such means is adapted for connection in a suitable conduit to conduct the materials caught in the inner vortex to a subsequent process step. In accordance with the concept and mode of operation of hydrocyclonic separators of the instant kind, air and relatively light and clean fibers from the slurry are gathered up by the inner vortex and conducted out the base end of the device as the accepted fraction while the remainder of the liquid suspension leaves the device through the apex end thereof.

A nozzle assembly in accordance with the instant invention provides vortex finding means as described and closure means as described for the overflow end of the separator. Thus, and referring to Figs. 1 and 2, a nozzle assembly in accordance with the illustrated embodiment of the invention comprises an open ended tube or cylinder 16 constituting the aforementioned nozzle. Secured to the exterior of the nozzle 16 intermediate its ends is a body 17 adapted to serve as a closure for the base or overflow end of the separator device and constructed and arranged to serve additionally as flow control means. The lower end of the nozzle 16, as viewed in the drawing is reduced in diameter to receive a sleeve 18 externally formed with a sloping bell-like surface 19 also performing a flow control function as will hereinafter more clearly appear. The body 17 is generally circular and includes a relatively wide flange portion 21 adapted to overlie and rest upon a complementary flange 22 on the end of cylindrical portion 13 of the shell 10. Bolt openings in the flange 21 enable attachment of the nozzle assembly to the shell. In concentric projecting relation to the flange 21 is a reduced diameter cylindrical portion 23 adapted to be received in the cylindrical shell section 13 with a substantially sliding fit. The underside of portion 23 is cut by a helix or helical surface 24 which in travelling once around the portion 23 achieves a longitudinal deflection equal at least to one diameter of inlet 14. The portion 23 and surface groove 24 cut therein terminate in a further reduced body portion 25 the periphery of which slopes gradually toward the axis of nozzle 16. Portion 25 in turn terminates in a transverse surface 26 so that such portion has the configuration of a truncated cone. Within the surface 26 is an annular depression in the form of a groove 27 semi-circular in cross-section.

The construction and arrangement of the nozzle assembly accordingly is one placing the opposite ends of the nozzle component 16 in projecting relation to the body 17. In the

installation of the assembly, as seen in Fig. 2, that end of the nozzle projecting through and beyond surface 26 of body 17 forms the inner end of the nozzle while the opposite end becomes the outer end thereof. Further the arrangement is one placing the nozzle 16 coaxially of the shell 10 so that the described inner vortex generated in the operation of the separator is aligned with and communicates with the inner end of the nozzle. The accepted fraction accordingly is conducted by the open ended nozzle from the inner end to the outer end thereof and is conducted thence to a place of use or storage by other means, the exterior of the outer end of the nozzle being threaded for attachment to a suitable conductor.

Still further in the installation of the nozzle assembly, such assembly is circumferentially located to position the upper or outer extremity of helical groove 24 opposite inlet 14. As a result the liquid suspension entering the separator at inlet opening 14 immediately encounters helical surface 24 and is deflected thereby gradually downward out of the transverse plane of such inlet opening. Accordingly, in the swirling rotary motion of the incoming slurry a helical control path is defined which prevents the slurry from moving back into the path of incoming material at the inlet opening. Thus entrance fluid shock conditions are avoided and turbulence minimized. The slurry tends to move in a smoothly flowing stream from the inlet into the swirling circular path through the separator, and, as a consequence, given or predetermined flow rates through the separator may be achieved and maintained under conditions of reduced pressure drop and with correspondingly less power consumption.

The truncated cone defined by body portion 25 is encountered by the slurry as it leaves helical surface 24 and tends to establish and to maintain the rotary swirling botion of the fluids, as well as aiding in the transition from entrance to separator body conditions.

The semi-circular groove 27 provides a means of deflecting longitudinally directed flow components in the moving slurry, again with the view of avoiding and minimizing turbulence in the entrance region. Considering this aspect of the operation in greater particularity, as indicated by the flow directional arrows in Fig. 2 portions of the flowing slurry tend to follow a bypassing or short circuiting path as they pass beneath the transverse plane of the inner nozzle extremity. Sleeve 18 counters or minimizes the effect of this tendency in that it throws or deflects outward current components moving inward adjacent to the nozzle. This action is effective in reducing to a minimum the by-passing of such eddy currents into the open inner end of the nozzle with a consequent contamination by a dirt-rich fraction of the clean accepted material rising into the nozzle by way of the centre vortex. There continues to be generated, however, a region of low radial velocity adjacent to the inner end of the nozzle wherein the fluid tends to turn back upon itself and move in a path shown by arrows 28 back into the entrance area of the separator. This flow is intercepted by the surface 26 of body unit 17 or more particularly by groove 27 therein. The curved surface of this groove reverses the fluid flow as indicated and redirects it downward into the separator proper in a path outward or radially offset.

The helically cut portion 23 of body unit 17 may be considered a roof for the overflow end of the separator, which roof is formed to produce a smooth downward deflection of the incoming liquid suspension. Truncated cone section 25 assists, as noted, in the transition movement from entrance to separator conditions of flow. Surface 26 and groove 27 therein constitute a roof for the region of low radial velocity with longitudinal circulation components as defined at the inner end of the nozzle, and is effective in conjunction with bell-shaped sleeve 18 to limit and control short circuiting flow in this region.

The nozzle assembly of the illustrated embodiment of the invention is a two-part device in which body 17 is made unitary and fastened to the separate nozzle part 16 by welding or like process. Also, bell-shaped part 18 is made separately and suitably secured as by weiding or by means of a press fit to the nozzle extremity. The complete assembly might, of course, be made in a single piece or the elements thereof made separable in arrangements different from that here shown.

The nozzle assembly of the instant invention introduces a new factor in the pattern of forces at work in the separator. The result thereof, as has been determined by observation and experimentation, is to significantly limit or to eliminate insuction through the underflow end of the separator. Insuction of either air or water frequently is undesirable so that vacuum systems applied to the apex or underflow end of the separator are in common use. The instant invention accordingly serves a further useful purpose in obviating the need for vacuum systems. The apex end of the separator may be immersed in water and the rejected fraction fed into such water without danger of drawing the dirt laden water into the separator and out the base end thereof along with the accepted slurry fraction. It is thus a part of the instant inventive concept to provide for use of a liquid separator in combination with a liquid bath,

running the separator with the underflow end or tip thereof submerged within such bath.

WHAT WE CLAIM IS:—

1. In a hydrocyclonic separator providing a hollow body formed with overflow and underflow ends and having at the overflow end a tangentially disposed laterally directed inlet for entrance of a liquid suspension or the like, a coaxially disposed overflow nozzle being received in said body at said overflow end and extending in intersecting relation to a plane including the longitudinal axis of said inlet; the improvement which includes an addition to said nozzle in said body in the form of a truncated cone section in surrounding relation to said nozzle at one end of which section is a peripheral helix adapted to receive and to guide the stream of liquid suspension from said inlet and at the other end of which is an annular depression facing the said underflow end of said body.

2. A hydrocyclonic separator according to Claim 1, characterised in that said overflow nozzle has an inner extremity in projecting relation to said truncated cone section, said extremity being peripherally formed with a bell shape to deflect the liquid suspension outward away from said nozzle.

3. A hydrocyclonic separator providing a hollow body formed with overflow and underflow ends and having at the overflow end a tangentially disposed laterally directed inlet for entrance of a liquid suspension or the like, a coaxially disposed overflow nozzle being received in said body at said overflow end and extending in intersecting relation to a plane including the longitudinal axis of said inlet; characterised by closure means for the said overflow end of said body including a roof portion received in and closing said overflow end and formed with a helix guiding the incoming slurry out of the transverse plane including the longitudinal axis of said inlet, said closure means terminating at its inner end in an annular depression facing the said underflow end of said body, said overflow nozzle projecting through and beyond the said inner end of said closure means, said annular depression being in adjacent surrounding relation to said nozzle.

4. A hydrocyclonic separator according to Claim 3, characterised further in that said depression in the inner end of said closure means is semi-circular in cross-section.

5. A hydrocyclonic separator providing a hollow body formed with overflow and underflow ends and with a lateral tangential inlet for admitting a slurry at the overflow end, and providing further an overflow nozzle coaxially disposed of said body and having an inner end projecting into said body through said overflow end to and beyond the transverse plane including the longitudinal axis of said inlet; characterised by means on said nozzle intermediate the inner extremity thereof and the said transverse plane affording a roof for longitudinally circulating currents of low radial velocity formed in said slurry external to said nozzle.

6. A hydrocyclonic separator according to Claim 5, characterised further by an annular groove formation in said roof tending to reverse the direction of flow of said longitudinally circulating currents encountering said roof.

7. A hydrocyclonic separator providing a hollow body formed with overflow and underflow ends and with a lateral tangential inlet for admitting a slurry at the overflow end, and providing further an overflow nozzle coaxially disposed of said body and having an inner end projecting into said body through said overflow end to and beyond the transverse plane including the longitudinal axis of said inlet toward said underflow end; characterised by closure means for the said overflow end of said body including a roof in closing relation to said overflow end, an auxiliary roof inwardly spaced toward said underflow end and a frusto-conical section interconnecting said roofs, said nozzle defining a central opening through said closure means and having portions projecting through and beyond said means.

8. A hydrocyclonic separator according to Claim 7 characterised further in that the first said roof of said closure means is formed with a helix guiding incoming slurry from said inlet out of the transverse plane of said inlet toward said underflow end, said auxiliary roof being formed with an annular depression encountered by current components of longitudinal circulation and of low radial velocity formed in said slurry external to said nozzle.

9. A hydrocyclonic separator providing a hollow body formed with overflow and underflow ends and with a lateral tangential inlet for admitting a slurry at the overflow end characterised by an overflow nozzle assembly installed in the said overflow end of said body, said assembly including a roof closing said overflow end and formed with a helix guiding slurry out of the transverse plane including the longitudinal axis of said inlet; said roof terminating at its inner end in an intermediate section of longitudinal extent in turn terminating in an auxiliary roof facing the said underflow end of said body, said assembly further including an open ended overflow nozzle extending at its inner end through and beyond the first said roof, said intermediate section and said auxiliary

roof being integrated with said nozzle into a unitary nozzle assembly as described.

10. A hydrocyclonic separator according to Claim 9 further characterised in that said auxiliary roof is formed with an annular groove semi-circular in cross-section surrounding the projecting inner end of said nozzle.

11. A hydrocyclonic separator according to Claim 9, further characterised by a bell formation on the projecting inner end of said nozzle beyond said auxiliary roof and presenting an externally projected sloping surface deflecting eddy currents in the flowing slurry away from the open inner end of said nozzle.

12. A hydrocyclonic separator according to Claim 9, further characterised in that said intermediate section is constructed as a cone of which said auxiliary roof is the truncated apex.

13. A hydrocyclonic separator substantially as described hereinbefore with reference to the accompanying drawings.

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955308 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig-1

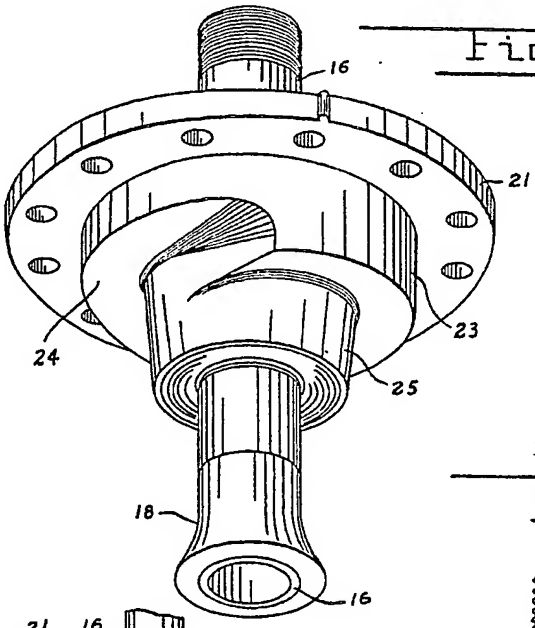
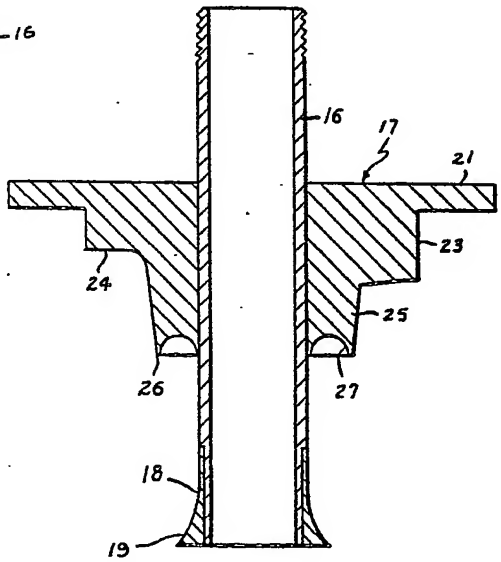


Fig-3



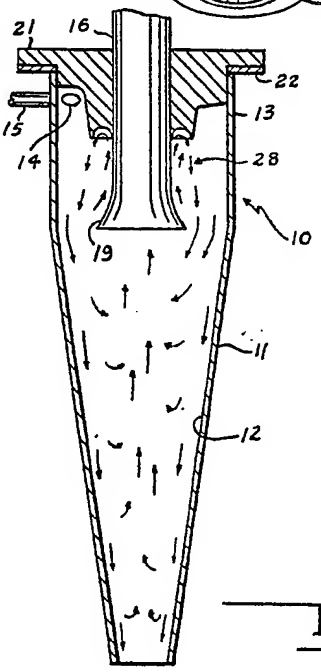


Fig-2